

# APPLICATION UNDER UNITED STATES PATENT LAWS

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Invention: LIGHT EMITTING DEVICE

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## SPECIFICATION

## **LIGHT EMITTING DEVICE**

[0001] This invention is based on Japanese application 2000-165864 filed June 2, 2000, which is hereby incorporated by reference.

### **BACKGROUND OF THE INVENTION**

#### **1. FIELD OF THE INVENTION**

[0002] The present invention relates to a light emitting device, and more particularly to a light emitting device suitable for use, for example, as white light sources for backlight or frontlight in liquid crystal display panels.

#### **2. DESCRIPTION OF RELATED ART**

[0003] Various light emitting devices for backlight in full color liquid crystal display panels are known. Generally, a light emitting device (LED) includes an LED chip array comprising an LED for red (R), an LED for green (G), and an LED for blue (B). A light guide section is generally provided such that light from the LED chip array enters therein through an incident face. The light is guided so as to propagate through the inside of the light guide section, thereby permitting planar backlight to be emitted through an outgoing face from the light guide section. Each of the LEDs for respective colors R, G, and B has a narrow-band emission spectrum. Therefore, upon light emission from each LED for R, G, and B, lights of R, G, and B from the respective LEDs can be mixed together to supply white backlight to a liquid crystal display panel. One such example is shown in Japanese Patent Laid-Open No. 329044/1999.

[0004] Radiation characteristics of each light emitting device varies from position to position and the speed of deterioration varies for each light emitting element. This tends to change the color balance over time. Light emitting elements having poor radiation characteristics can generally cause lowered power output and have shortened service life, which is undesirable.

[0005] Some light emitting elements, such as G and B, have both positive and negative electrodes on light emitting faces thereof, which can increase the number of bonding

elements coupled to the light emitting elements. With more bonding elements coupled to the light emitting elements, a compact packaging arrangement is difficult to achieve.

### SUMMARY OF THE INVENTION

[0006] Accordingly, it is an aspect of embodiments of the invention to provide a light emitting device in which homogeneous radiation characteristics can be obtained and, thus, no significant change balance in color results from the elapse of time.

[0007] It is another aspect of embodiments of the invention to provide a light emitting device in which improved radiation efficiency is obtained and unfavorable phenomena such as lowering in power output and shortening of service life of light emitting elements can be avoided.

[0008] It is a further aspect of embodiments of the invention to provide a light emitting device having a compact structure.

[0009] According to a first feature of the invention, a light emitting device includes an insulating base having positive and negative leads, respectively, provided on top and bottom surfaces thereof. A LED chip array is arranged on the negative lead on the top surface of the insulating base. The LED chip array is electrically connected to the positive and negative leads on the top surface of the insulating base. A first metal connection connects the positive leads on the top and bottom surfaces of the insulating base; and a second metal connection connects the negative leads on the top and bottom surfaces of the insulating base.

[0010] According to a second feature of the invention, a light emitting device includes a pair of metal layers provided respectively on the upper and lower surfaces of an insulating base. A plurality of light emitting elements are arranged on the metal layer provided on the upper surface of the insulating base, and a metal connection connects the pair of metal layers to each other at a position where at least one of the of the plurality of light emitting elements is disposed.

[0011] According to this construction, heat generated from the plurality of light emitting elements is released through the metal layer provided on the upper surface of the insulating base into the air, and, in addition, is transferred through the metal connection to the metal

layer provided on the lower surface of the insulating base and is then released into the air. Further, since the radiating surface is increased, the radiation efficiency can be improved.

[0012] According to a third feature of the invention, a light emitting device includes a substrate comprising a plurality of leads provided on an insulating base. A plurality of light emitting elements are arranged on a base line along the surface of the substrate in its predetermined direction. A plurality of bonding wires connect the plurality of light emitting elements to the plurality of leads in the predetermined direction or on one side relative to the base line.

[0013] According to this construction, in the connection of the plurality of light emitting elements to the plurality of leads through bonding wires, this connection is carried out in such a state that the bonding wire has been rendered eccentric. This can reduce the size of the device in a direction perpendicular to a direction in which the plurality of light emitting elements are arrayed. The plurality of light emitting elements comprise a first light emitting element having first and second electrodes on its light emitting face side and a second light emitting element having a first electrode on its light emitting face side and a second electrode on its side remote from the light emitting face. The term "light emitting element" as used herein means a bared chip, such as LED (light emitting diode) having first and second electrodes. The term "substrate" refers to, for example, a printed board formed by providing leads connected to first and second electrodes on a base by a circuit printing method, and a substrate having a lead frame structure formed by placing a lead frame, corresponding to leads connected to first and second electrodes, within a mold and pouring an insulating material into the mold.

[0014] According to a fourth feature of the invention, a light emitting device includes a pair of metal layers provided respectively on the upper surface and lower surface of an insulating base. A plurality of light emitting elements are arranged on a base line along the surface of the metal layer, in its predetermined direction, provided on the upper surface of the insulating base. A metal connection connects the pair of metal layers to each other at a position where a predetermined light emitting element out of the plurality of light emitting elements is disposed. A plurality of bonding wires connect the plurality of light emitting elements to the metal layer, provided on the upper surface of the insulating base, in the predetermined direction or on one side relative to the base line.

[0015] According to this construction, heat generated from the plurality of light emitting elements is released through the pair of metal layers provided respectively on the upper and lower surfaces of the insulating base into the air. In addition, in the connection of the plurality of light emitting elements to the plurality of leads through bonding wires, this connection is carried out in such a state that the bonding wire has been rendered eccentric. This can reduce the size of the device in a direction perpendicular to a direction in which the plurality of light emitting elements are arrayed.

[0016] According to a fifth feature of the invention, a light emitting device for driving a plurality of LED chips disposed in an array to emit a mixed light composed of lights emitted from the plurality of LED chips, an insulating base having an upper surface and a lower surface. An LED chip connection lead is provided on the upper surface of the insulating base. A power supply connection lead is provided on the lower surface of the insulating base. A link lead connects the LED chip connection lead to the power supply connection lead between the upper and lower surfaces of the insulating base. The LED chip connection lead comprises a plurality of separate leads connected respectively to the plurality of LED chips and a common lead, to which the plurality of LED chips are connected by common connection and which is loaded with the plurality of LED chips, for absorbing heat generated from the plurality of LED chips.

[0017] According to this construction, heat generated from the plurality of LED chips is released, through a common lead in the LED chip connection lead provided on the upper surface of the insulating base, into the air, and, in addition, is transferred through the link lead, to the power supply connection lead provided on the lower surface of the insulating base, and is then released into the air. Further, since the radiating surface is increased, the radiation efficiency can be improved.

[0018] These and other aspects and features of this invention will be described in or apparent from the following detailed description when taken in conjunction with the accompanying drawings, which are a part of this disclosure and which illustrate, by way of example, preferred embodiments of the invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The invention will be explained in more detail in conjunction with the appended drawings, wherein:

[0020] Fig. 1A is a diagram showing the upper surface of the light emitting device in a first preferred embodiment of the invention;

[0021] Fig. 1B is a cross-sectional view taken on line I-I of Fig. 1A;

[0022] Fig. 1C is a diagram showing a metal pattern provided on the upper surface of the light emitting device;

[0023] Fig. 1D is a diagram showing the lower surface of the light emitting device;

[0024] Fig. 2A is a plan view showing an embodiment of the application of the light emitting device according to the first preferred embodiment of the invention to a backlight apparatus;

[0025] Fig. 2B is a cross-sectional view taken on line II-II of Fig. 2A;

[0026] Fig. 2C is a cross-sectional view taken on line III-III of Fig. 2A;

[0027] Fig. 3 is a diagram showing an LED drive circuit in the light emitting device according to the first preferred embodiment of the invention;

[0028] Fig. 4 is a perspective view of the principal part of an assembly comprising the light emitting device according to the first preferred embodiment of the invention incorporated into a backlight apparatus;

[0029] Fig. 5 is a plan view showing an embodiment of the application of the light emitting device according to the first preferred embodiment of the invention to a backlight apparatus;

[0030] Fig. 6 is a plan view showing an embodiment of the application of the light emitting device according to the first preferred embodiment of the invention to a backlight apparatus;

[0031] Fig. 7A is a diagram showing the upper surface of the light emitting device showing a light emitting device according to a second preferred embodiment of the invention;

[0032] Fig. 7B is a cross-sectional view taken on line IV-IV of Fig. 7A;

[0033] Fig. 7C is a diagram showing a metal pattern provided on the upper surface of the light emitting device;

[0034] Fig. 7D is a diagram showing the lower surface of the light emitting device;

[0035] Fig. 8A is a diagram showing the upper surface of a light emitting device according to a third preferred embodiment of the invention;

[0036] Fig. 8B is a front view;

[0037] Fig. 8C a cross-sectional view taken on line V-V of Fig. 8A; and

[0038] Fig. 8D is a cross-sectional view taken on line VI-VI of Fig. 8A.

#### DESCRIPTION OF PREFERRED EMBODIMENTS

[0039] Figs. 1A, 1B, 1C and 1D show a light emitting diode or device (LED) in accordance with the principles of the present invention. For the facilitation of understanding, in Fig. 1A, a case and a filling member are not shown, and, in Fig. 1C, a resin is not shown. The light emitting device 1 comprises a printed circuit board 2A on which a metal pattern to be loaded with LED has been printed. A plurality of LEDs 3 (3R (red), 3G (green), 3B (blue)) are disposed in an array. The LED array 3 is electrically connected to the positive and negative leads on the upper surface 2a of the printed circuit board 2A. A case 4 having an opening 4a provided so as to surround the plurality of LEDs 3. A filling member 5, for example, of a transparent epoxy resin, fills the opening 4a and seals the plurality of LEDs 3 in the case 4.

[0040] The printed circuit board 2A includes a base 2 having upper, lower and side surfaces 2a, 2c, 2b, respectively. Preferably, the printed circuit board 2A can be produced in a small size at low cost so that an inexpensive and small-size light emitting device can be achieved.

[0041] The base 2 is formed of a material having heat resistance and high white reflectance, for example, a glass-epoxy resin containing a white colorant having high white reflectance. The printed circuit board 2A also has a metal pattern comprising separate leads 6R, 6G, 6B respectively for red (R), green (G) and blue (B) light elements 3R, 3G and 3B, respectively, printed on the upper surface 2a of the base 2. The printed circuit board 2A also has a common lead 6C common to each light element 3R, 3G, 3B included in the plurality of LEDs

3. A resist 12 (Fig. 1B) is applied to the lower surface 2c of the base 2 and is configured to help prevent short circuiting among leads 6R, 6G, 6B, 6C.

[0042] The separate leads 6R, 6G, 6B comprise electrode faces 6R<sub>1</sub>, 6G<sub>1</sub>, 6B<sub>1</sub> provided on the upper surface 2a of the base 2 and connections 6R<sub>2</sub>, 6G<sub>2</sub>, 6B<sub>2</sub> provided on the lower surface 2c of the base 2. The common lead 6C comprises an electrode face 6C<sub>1</sub> provided on the upper surface 2a of the base 2, a connection 6C<sub>2</sub> provided on the side face 2b of the base 2 and a heat radiating section 6C<sub>3</sub> provided on the lower surface 2c of the base 2. The electrode face 6C<sub>1</sub> in the common lead 6C has a substantially  $\supset$  shape, but could be configured to have other shapes as well, for example, any arcuate configuration.

[0043] The electrode faces 6R<sub>1</sub>, 6G<sub>1</sub>, 6B<sub>1</sub> of the separate leads 6R, 6G, 6B provided on the upper surface 2a of the base 2 are connected to the connections 6R<sub>2</sub>, 6G<sub>2</sub>, 6B<sub>2</sub>, which are provided on the lower surface 2c of the base 2. Through-hole platings 9R, 9G, 9B and a solder 11 filled into the through-hole platings 9R, 9G, 9B connect the electrode faces 6R<sub>1</sub>, 6G<sub>1</sub>, 6B<sub>1</sub> to the connections 6R<sub>2</sub>, 6G<sub>2</sub>, 6B<sub>2</sub>. The electrode face 6C<sub>1</sub> in the common lead 6C provided on the upper surface 2a of the base 2 is connected to the heat radiating section 6C<sub>3</sub> provided on the lower surface 2c of the base 2 via through-hole platings 10R, 10G, 10B. Solder 11 is filled into the through-hole platings 10R, 10G, 10B, and the connection 6C<sub>2</sub>. The through-hole platings 10R, 10G, 10B are provided adjacent to and below the LEDs 3G, 3B. The LEDs 3G, 3B can generate a large quantity of heat, among the plurality of LEDs 3.

[0044] The side face 2b of the base 2 functions as a face for mounting to a light emitting device mount substrate, as will be described in greater detail below. The connections 6R<sub>2</sub>, 6G<sub>2</sub>, 6B<sub>2</sub>, 6C<sub>2</sub> are connected to a wiring pattern provided on the light emitting device mount substrate 21 (Figs. 2A, 2B and 2C).

[0045] The plurality of LEDs 3 comprise a blue light emitting element 3B disposed in the center of the array of LEDs, two red light emitting elements 3R disposed adjacent and on opposite sides of the blue light emitting element 3B and two green light emitting elements 3G disposed adjacent to and on opposite sides of the blue light emitting elements 3B. The red light emitting element or LED 3R is formed of, for example, an AlInGaP-base semiconductor which emits red light. The red LED 3R has a first electrode 3a on its upper surface 6R<sub>1</sub> and a second electrode 3b on its lower surface. The first electrode 3a on the upper surface 2a is electrically connected to the electrode face 6R<sub>1</sub> of the separate lead 6R for R, for example,



using a bonding wire 7R. The second electrode 3b on the lower surface 2c is electrically and mechanically connected to the electrode face 6C<sub>1</sub> of the common lead 6C and may be bonded thereto, for example, using a conductive adhesive. The green LED 3G comprises, for example, a GaN-base semiconductor which emits a green light. The green LED 3G has a first electrode 3a and a second electrode 3b on its upper surface. The lower surface is mechanically connected to the electrode face 6C<sub>1</sub> of the common lead 6C with the aid of an adhesive.

[0046] As best shown in Fig. 1A, the first electrode 3a is electrically connected to the electrode face 6G<sub>1</sub> for G through the bonding wire 7G. The second electrode 3b is electrically connected to the common electrode face 6C<sub>1</sub> through a bonding wire 8G. The blue LED 3B comprises, for example, a GaN-base semiconductor which emits blue light. The blue LED 3B has a first electrode 3a and a second electrode 3b on its upper surface. The lower surface is mechanically connected to the electrode face 6C<sub>1</sub> of the common lead 6C with the aid of an adhesive. The first electrode 3a is electrically connected to the electrode face 6B<sub>1</sub> for B through a bonding wire 7B. The second electrode 3b is electrically connected to the common electrode face 6C<sub>1</sub> through a bonding wire 8B. The LEDs 3R, 3G, 3B respectively for colors R, G, and B have a light intensity ratio of, for example, 1 : 3 : 1. Therefore, when numbers corresponding to light intensity ratio of the blue LED 3B, the red LED 3R, and the green LED 3G are used, as described above (one, two, and two, respectively), for example, an optimal intensity ratio of lights R, G, and B for providing white light through mixing of lights R, G, and B

[0047] (for example, R : G : B = 2 : 6 : 1) can be realized.

[0048] The insulating base 2 and the case 4 are formed of a material having high white reflectance, thus a high level of reflection can be realized for all emission wavelengths of R, G, and B. Since all emission wavelengths of R, G and B can be enhanced, the power used can be reduced. The case 4 may be formed of, for example, a white resin, such as polyphthalamide with a white colorant having high white reflectance incorporated therein or may be formed of a resin wherein a white coating is applied onto the opening 4a.

[0049] The printed circuit board 2A can be loaded with the LED 3 and may be mounted onto the light emitting device mount substrate 21, followed by mounting onto the printed circuit board 2A, as shown in Fig. 2A. The case 4 can be mounted on the board 2A, such that the

draft angle of the opening 4a can be reduced. The opening 4a defined by the case 4 can be any configuration although shown as a generally annular opening in Fig. 1A.

[0050] As best seen in Fig. 1A, the opening 4a is provided so that the center of the plurality of LEDs 3 is spaced from the center of the opening 4a by a distance "e". In the illustrated embodiment, the distance "e" is shown in a direction perpendicular to the horizontally aligned array of LEDs 3, but the distance "e" could also be formed in a direction along the LEDs shown in Figs. 1A, 1C and 1D.

[0051] In the light emitting device 1, heat from the LEDs 3G, 3B, which generate a relatively large quantity of heat, is released through the common lead 6C into the air. The heat is also transferred through the through-hole platings 10R, 10G, 10B and the solder 11 before being released into the air through the common lead 6C provided on the lower surface 2c of the insulated base 2. This allows radiation characteristics among the LEDs 3R, 3G, 3B to be homogenized, and, thus, a change in color balance over time is reduced. Further, unfavorable phenomena, such as lowered power output and shortened service life, caused by a temperature rise of the LED 3 can be avoided. Since the radiating surface is increased, the radiation efficiency can be improved, which makes it possible to avoid the unfavorable phenomena, such as lowered power output and shortened service life of the LED 3.

[0052] As best seen in Fig. 1A, bonding wires 7R, 7G, 7B, 8R, 8G, 8B extend toward the array of LEDs 3 and are extended from this array toward one side thereof. The plurality of LEDs 3 can be disposed in an eccentric state relative to the opening 4a. This reduces the width  $W_1$  of the opening 4a, and can realize a compact structure such that the width  $W_2$  of the device 1 has been reduced.

[0053] In mixing lights R, G, and B to form white light, light can be emitted from the blue LED 3B at full power. Therefore, light can be efficiently emitted. Further, since the base 2 and the case 4 are formed of a material having high white reflectance, a high level of reflection can be realized for all emission wavelengths of R, G, and B. Therefore, the emission efficiency can be enhanced, and the power can be reduced. Additionally, the printed board 2A used is one which can be produced in a small size at low cost. This can provide an inexpensive and small-size light emitting device.

[0054] In Fig. 1A, LEDs 3G, 3R, 3B, 3R and 3G for colors G, R, B, R and G are arranged to be arrayed in the horizontal direction. The arrangement of LEDs may be changed as LEDs

arranged respectively for colors R, G, B, G and R in the horizontal direction. Even in this arrangement, the same advantage as the first preferred embodiment is obtained. On the other hand, the arrangement of LEDs for colors R, B, G, B and R to be arrayed may be adopted, when bluish white light is required to be emitted from the arrangement of LEDs.

[0055] Figs. 2A to 2C show a backlight apparatus 20 including the light emitting device 1. The backlight apparatus 20 comprises a light emitting device mount substrate 21, the light emitting device 1 and a light guide section 23. The light emitting device mount substrate 21 includes an LED drive circuit (Fig. 3) having a wiring pattern on its surface 21a. The light emitting device 1 is provided on one end of the light emitting device mount substrate 21 and has leads 6R, 6G, 6B, 6C connected to a wiring pattern on the light emitting device mount substrate 21. Light from the light emitting device 1 enters the light guide section 23 through an incident face 23a thereof and is guided so as to propagate through the inside of the light guide section 23, thereby permitting planar white backlight to be exit from the light guide section 23 through an outgoing face 23b.

[0056] The light guide section 23 comprises a light guide plate 230 formed of a transparent material, such as polycarbonate, acryl, or glass, a reflection plate 231 which is provided on the backside 230a of the light guide plate 230 and a diffusion plate 232. The reflection plate 231 is formed of a white film of polyethylene terephthalate or the like and is configured to reflect light incident to the incident face 23a from the light emitting device 1. The diffusion plate 232 is provided on the surface 230b of the light guide plate 230 and is formed of, for example, a polycarbonate film having concave and convex portions in the outgoing face 23b. The diffusion plate 232 is configured to diffuse light which is incident from the light emitting device 1 to the incident face 23a and to diffuse light which is reflected from the reflection plate 231.

[0057] Fig. 3 shows the LED drive circuit provided on a light emitting device mount substrate 21. As illustrated, the LED drive circuit comprises a power supply 14 and a control unit 16. The power supply 14 is configured to apply a drive voltage to the anode or positive lead of each of LEDs 3R, 3G, 3B while the control unit 16 is connected to the cathode or negative lead of each of LEDs 3R, 3G, 3B. The control unit 16 connects to the LEDs 3R, 3G, 3B through transistors 15R, 15G, 15B and control resistors 17R, 17G, 17B so as to control the light emission from the LEDs 3R, 3G, 3B. The control unit 16 also controls the power supply 14. In the illustrated LED drive circuit, the LEDs 3R, 3G, 3B can simultaneously emit

light and white backlight can be output. Light of any color can be emitted from the LEDs 3R, 3G, 3B by separately emitting light from the LEDs 3R, 3G, 3B, or by varying the luminous intensity from the LEDs 3R, 3G, 3B for the desired color.

[0058] Fig. 4 shows an assembly comprising the light emitting device 1 and the backlight apparatus 20. In incorporating the light emitting device 1 and the backlight apparatus 20 into the illustrated assembly, the light emitting device 1 is first mounted on the light emitting device mount substrate 21. A wiring pattern 22, provided on the surface 21a of the light emitting device mount substrate 21, connects to the connections 6R<sub>2</sub>, 6G<sub>2</sub>, 6B<sub>2</sub>, 6C<sub>2</sub> of the light emitting device 1, for example, by using a solder 13. Next, an adhesive or epoxy can bond the case 4 to the upper surface 2a of the printed circuit board 2A, for example, and thereafter the filling member 5 fills the inside of the opening 4a and hermetically seals the LEDs 3R, 3G, 3B in the case 4. The light guide section 23 of the backlight apparatus 20 is mounted onto the light emitting device mount substrate 21.

[0059] Alternatively, in an embodiment not shown, the light emitting device 1 could directly mount onto the light emitting device mount substrate 21 to easily mount the light emitting device 1 onto the light emitting device mount substrate 21. In this configuration, the case 4 and the filling 5 could be omitted from the assembly.

[0060] When the light emitting device 1 is mounted onto the light emitting device mount substrate 21, connection is performed through the solder 13 in the connections 6R<sub>2</sub>, 6G<sub>2</sub>, 6B<sub>2</sub>. The connections 6R<sub>2</sub>, 6G<sub>2</sub>, 6B<sub>2</sub> are provided on the lower surface 2c of the substrate 2A while the connection 6C<sub>2</sub> is provided on the side face 2b. This configuration can prevent the board 2A from being toppled backward, for example.

[0061] As best seen in Figs. 2A, 2B and 2C, the backlight apparatus 20 is configured such that the LEDs 3 for respective colors are densely disposed to create a state close to a point light source. Therefore, white light can be homogeneously diffused within the light guide plate 230. As a result, a diffusion homogeneity of not less than 60% in terms of minimum brightness relative to the maximum brightness can be ensured in the outgoing face 23b of the light guide section 23. This diffusion homogeneity can prevent color shading in full color liquid crystal display panels, for example.

[0062] The thickness of the backlight apparatus 20 can be reduced by reducing the width W<sub>1</sub> of the opening 4a in the light emitting device 1.

[0063] Other embodiments of the light emitting device 1 and the backlight apparatus 20 will be described below. In the descriptions of the further embodiments, only the points of difference of each embodiment from the first embodiment will be described. That is, in those embodiments, the constituent parts the same as those in the first embodiment are referenced correspondingly in the drawings and the description about them will be omitted.

[0064] Fig. 5 shows a backlight apparatus 120, which is an alternative embodiment of the backlight apparatus 20 shown in Fig. 2. The backlight apparatus 120 includes two incident faces 123a of the light guide section 123 provided on one side thereof. One light emitting device 1 is provided on each incident face 123a. By providing two incident faces 123a, more homogeneous emission characteristics can be realized in the widthwise direction for the backlight apparatus 120.

[0065] Fig. 6 shows backlight apparatus 220, which is another alternative embodiment of the backlight apparatus 20 shown in Fig. 2. The backlight apparatus 220 includes the two diametrically opposed incident faces 23a. The incident faces 23a are provided on both sides of the light guide section 23 and each include one light emitting device 1 provided thereon. By providing two incident faces 123a on opposite sides of the backlight apparatus 220, more homogeneous emission characteristics can be realized in the longitudinal direction for the backlight apparatus 220.

[0066] In Figs. 7A to 7D, a light emitting device 1b is shown. Light emitting device 1b is an alternative embodiment of the light emitting device 1. The light emitting device 1b has the same construction as the light emitting device 1, except that the LEDs 3R, 3G, 3B are disposed at the center of the opening 4a in the case 4, rather than being spaced a distance "e" therefrom. Also, as shown in Fig. 7A, the bonding wires 7R, 7G, 7B and 8R, 8G, 8B, respectively, are vertically spaced from one another. Since the bonding wires 7R, 7G, 7B, 8R, 8G, 8B are vertically spaced from one another, the pitch of the LEDs 3R, 3G, 3B in the longitudinal direction can be reduced. Thus, the size in the direction of length L can be reduced. Additionally, the electrode face 6C<sub>1</sub> of the common lead 6C according to the second preferred embodiment has a substantially H shape.

[0067] In Figs. 8A to 8D, a light emitting device 1c is shown. The light emitting device 1c has the same construction as the light emitting device 1, except that a substrate 2B having a

lead frame structure is used instead of the printed circuit board 2A and a case 4', corresponding to the case 4, is formed of the same material as the base 2.

[0068] The substrate 2B comprises a substrate 2 formed of a material having heat resistance and high white reflectance. Separate leads 6R, 6G, 6B for respective colors R, G, and B are incorporated into the base 2 when the base 2 is molded. A common lead 6C is common to the plurality of LEDs 3. The leads 6R, 6G, 6B, 6C comprise electrode faces 6R<sub>1</sub>, 6G<sub>1</sub>, 6B<sub>1</sub>, 6C<sub>1</sub>, provided on the upper surface 2a of the base 2, and connections 6R<sub>2</sub>, 6G<sub>2</sub>, 6B<sub>2</sub>, 6C<sub>2</sub> provided on the side face 2b of the base 2. The connection 6R<sub>2</sub> for R and the connection 6G<sub>2</sub> for G are extended toward the case 4'. A concave surface 2d for receiving the connections 6R<sub>2</sub>, 6G<sub>2</sub>, 6B<sub>2</sub>, 6C<sub>2</sub> is provided in the base 2. Leads 6R, 6G, 6B, 6C may be formed by placing a lead frame within a mold, pouring a material for the base 2 into the mold to mold the substrate 2B provided with the case 4', cutting the lead frame into a predetermined shape, and then bending the lead frame.

[0069] The light emitting devices 1b or 1c can be incorporated into any one of the backlight apparatuses 20, 120, 220. For example, when incorporating the light emitting device 1c into the backlight apparatus 20, the connections 6R<sub>2</sub>, 6G<sub>2</sub>, 6B<sub>2</sub>, 6C<sub>2</sub> and the filling member 5 are connected to the wiring pattern provided on the light emitting device mount substrate 21 through a solder. This effectively mounts the light emitting device 1 on the light emitting device mount substrate 21.

[0070] When the light emitting device 1 is incorporated into the backlight apparatus 20, the post-mounting work of the case 4 after mounting the light emitting device 1 onto the light emitting device mount substrate 21 can be eliminated. Therefore, the light emitting device 1 can be easily mounted onto the light emitting device mount substrate 21..

[0071] Further, since the leads 6R, 6G, 6B, 6C in the substrate 2B having a lead frame structure, they each can function as a heat sink. Therefore, a highly heat-resistant package can be produced.

[0072] Light emitting elements, all of which emit an identical color light, may be used as the light emitting elements mounted on the substrate. Regarding the through-hole plating provided just under light emitting elements which generate a large quantity of heat, one or a plurality of through-hole platings may be provided around the light emitting elements which generate a large quantity of heat.

[0073] As is apparent from the foregoing description, according to the light emitting device of the invention, heat generated from a plurality of light emitting elements are released through a metal layer and metal connections into the air. By virtue of this, when a plurality of light emitting elements are used, radiation characteristics can be homogenized, and, thus, a change in color balance with the elapse of time can be reduced.

[0074] Further, since the radiation surface is increased, the radiation efficiency can be improved, and thus, unfavorable phenomena of light emitting elements, such as lowered power output and shortened service life, can be avoided.

[0075] Furthermore, in connecting a plurality of light emitting elements to a plurality of leads, this connection is carried out in such a state that the bonding wire has been rendered eccentric. This can reduce the size of the device in a direction perpendicular to a direction in which the plurality of light emitting elements are arrayed.

[0076] The invention has been described in detail with particular reference to preferred embodiments, but it will be understood that variations and modifications can be effected within the scope of the invention as set forth in the appended claims.

[0077] Since numerous modifications and changes to the embodiments described above will readily occur to those of ordinary skill in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described. Accordingly, all suitable modifications and equivalents should be considered as falling within the spirit and scope of the invention.